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CD NO.

SUPPLEMENT TO
REPORT NO.

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SOURCE Ugol', No 12, 1950.

USSR PLANTS EXPERIMENT WITH NEW COKING CHARGE

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The coke by-products plants of the southern USSR have for a long time experienced a shortage of K and PS coal. For this reason, USSR research workers are occupied with the problem of finding methods and ways of replacing these types of coal with other less scarce types.

The Stalinskiy Coke By-Products Plant, operating on a coke charge containing no K coal (PS coal, 27 percent; G coal, 25 percent; PZh coal, 48 percent), saved more than 200,000 tons of K coal from 1 July 1949 to the present. It can be asserted that average-size blast furnaces are able to operate on such coke without deterioration of the qualitative or quantitative indexes in smelting pig iron. Other coke by-product plants which supply coke to blast furnaces of approximately the same capacity could be converted to this new charge of the Stalinskiy Coke By-Products Plant in proportion to their requirements.

However, the shortage of PS coal has prevented the plants from converting to the new charge, especially since the new charge contains 27 percent of PS coal, while the present charge contains 20 percent.

In efforts to replace scarce PS coal, experiments were made (15 October 1949 - August 1950) with long-flame coal from Kurakhovka Mine No 40 (seams 1g and 1g₁) of the Krasnoarmeyakugol' Trust. Run-of-the-mine coal is divided into two classes: coal larger than 25 millimeters and coal smaller than 25 millimeters. After stones have been removed from the larger coal, it is mixed with the smaller and sent to the loading bunkers where it is rescreened into two classes, DK, larger than 25 millimeters, and DM, smaller than 25 millimeters. The mine output is approximately 45 percent DK coal and 55 percent DM. On the average, DK coal contains 9.5 percent ash and 1.8 percent sulfur, while DM coal contains 16 percent ash and 2.1 percent sulfur. The moisture content of D coal ranges from 8-9 percent and it does not freeze in winter.

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DM coal was used for the experimental coking; the first lot, intended for a study on the concentration of coals, contained 16.6 percent ash, 2.1 percent sulfur, 45.7 percent volatile matter in the fuel mass, and yielded 78 percent concentrate with an ash and sulfur content of 5 and 1.4 percent respectively. The plastometric indexes are: thickness of plastic layer -- zero; final settling -- 35 millimeters. The coke bead of the crucible test, as well as of the plastometric test, did not cake but appeared as powder.

Since the coal from Kurakhovka Mine No 40 apparently contains no appreciable amount of fusible substances, the question arises as to what constituents of the coke charge can be replaced by coal from this mine. Two things of primary importance in the composition of a coke charge are (1) there must be an adequate amount of fusible substances in the charge to ensure the production of well-fusing coke; (2) these substances must be of such a type that the most favorable pressure results when the charge bulges and gases are released, since a certain pressure is necessary to produce compact large-lump coke.

In coking with a 100-percent G or PZh charge, tough coke is not obtained despite the fact that both of these coals have a completely adequate amount of fusible substances. The coke in this case is spongy because the pressure is inadequate. On the other hand, K and PS coal, particularly the latter, have only a small amount of fusible substances, but in the process of coking with these coals, considerable pressure results.

The following table gives the pressure resulting during coking when the charge bulges and gases are released for different types of coal:

Table 1.

<u>Types of Coal</u>	<u>Pressure (kg/sq m)</u>
G	0.01-0.115
PZh	0.04-0.30
K	0.22-0.57
PS	0.34-0.80

The results in the above table were obtained by using a laboratory furnace with movable walls. Long-flame coal from Kurakhovka Mine No 40 was characterized by no pressure when tried out in the apparatus with movable walls. If D coal is to be introduced into a coke charge, it is necessary to remove PS coal from the charge to retain an adequate amount of fusible substances and to increase somewhat the proportion of K coal in order to have the most favorable pressure during the bulging of the charge. In this way, D coal should be used to replace scarce PS coal. Box coking was undertaken to verify this by the coal-preparation shop, laboratory, and the OTK (Technical Control Department of the Stalinskiy Coke By-Product Plant). Four variants of the usual charge were tested:

Table 2.

<u>Type of Coal</u>	<u>Variants of Charges (%)</u>				
	<u>Usual</u>	<u>I</u>	<u>II</u>	<u>III</u>	<u>IV</u>
D	--	15	20	10	15
G	20	15	--	20	15
PZh	42	35	50	40	40
K	20	35	30	30	15
PS	18	--	--	--	15
Total	100	100	100	100	100

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G coal was used from Dobropel'ye Mine No 17/18 of the Krasnoarmeyskugol' Trust, PZh coal from the Sergey Mine of the Makeyevugol' Trust, K coal from the Mine imeni K. Marks, and PS coal from Krasnyy Oktyabr' Mine No 1-2 of the Ordzhonikidzeugol' Trust. The best coke was obtained from variants No I and III.

A series of cokings was carried out by the coal-preparation and coke shops, the laboratory, and the OTK, using three additional variants of the coke charge. These variants are as follows:

Table 3.

Types of Coal	Variants of Charge (%)		
	1	2	3
D	15	10	10
G	20	20	20
PZh	35	40	45
K	30	20	25
PS	--	10	--
Total	100	100	100

The results of the series of coking with the three variant charges, indicated in the preceding table, are shown in the following table:

Table 4.

	Variants of Charge		
	1	2	3
Quality of charge			
Moisture (%)	10.5	9.8	9.5
Ash content (%)	7.2	7.4	7.3
Sulfur content (%)	1.89	1.98	1.92
Volatile matter in dry mass (%)	28.0	28.0	30.6
Pulverization (0-3mm) (%)	88.9	91.9	87.6
Bulging pressure (kg/sq m)	0.09	0.16	0.09
Operation of coke ovens			
No of experimental ovens	14	13	10
Coking duration (hr)	15.5	15.0	15.1
Temperature (°C)			
Machine side	1,290	1,283	1,282
Coke side	1,340	1,347	1,343
Reading of ammeter at yield of coke	212	186	178
Quality of coke			
Ash content (%)	10.5	10.5	10.1
Sulfur content (%)	1.61	1.57	1.61
Drum specimen (kg)			
Residue	320	306	320
Screened size (%)			
0-10 mm	46	47	44
10-25 mm	11	11	10
Above 25 mm	33	46	36

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The second variant proved to be unsatisfactory, while the third was the best. An experimental consignment, 500 tons, of the third mixture was sent to the blast-furnace shop of the Yenakiyevo Metallurgical Plant. Detailed tests by the experimental station gave a satisfactory total area of destruction: 29 square meters instead of 26 square meters for ordinary coke. Such positive results posed the question of carrying out experimental blast-furnace melts using the new coke.

Continuous industrial coking and experimental blast-furnace melts were carried on in two stages by the coke by-products plant and the metallurgical plant. In the first stage, 450-500 tons of the experimental coke were supplied daily to blast furnace No 1 and this made it necessary for 50 coke ovens to operate 19-23 hours daily on variant No 3. The experimental coke was discharged from the ovens in from 10 to 14 hours and was sent in hopper cars to blast furnace No 1.

Results of the first stage of 10 days of experimentation are given in the following table which, for purposes of comparison, also gives data on the preceding 20 days:

Table 5.

	<u>22 Jun - 2 Jul</u>	<u>20 Days of Jun</u>
Quality of run-of-mine coal (%)		
Ash content	17.48	17.32
Sulfur content	2.53	2.53
Volatile matter in dry mass	26.96	24.35
Quality of cleaned charge (%)		
Moisture	9.64	9.48
Ash content	7.55	7.57
Sulfur content	2.01	2.08
Volatile matter in dry mass	26.69	24.58
Operation of coke ovens		
Coking duration (hr)	15.05	15.11
Temperature (°C)		
Machine side	1,342	1,344
Coke side	1,399	1,400
Average reading of ammeter		
Battery No 1	176	179
Battery No 2	174	181
Battery No 3	216	215
Battery No 4	218	217
Quality of coke (%)		
Moisture	2.82	2.73
Ash content	10.39	10.63
Sulfur content	1.68	1.69
Volatile matter	1.03	1.01
Drum specimen (kg)		
Residue	328	333
Screened size, 0-10 mm	33.5	28.2
Screened size, 10-25 mm	7.2	7.2
Screened size, above 25 mm	41.3	41.6
Fracturing (cm/sq cm)	0.112	0.103
Screened distribution of skip coke (%)		
Above 80 mm	33.7	11.9
40-80 mm	60.1	68.2
25-40 mm	5.5	18.5
Below 25 mm	0.7	1.4

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The results of operations of blast furnace No 1, using the new coke, are as follows:

Table 6.

	<u>22 Jun - 2 Jul</u>	<u>20 Days of Jun</u>
Productivity (ton)	494	486
Coefficient of utilization of useful volume (cu m/ton)	0.895	0.910
Coke consumption per ton of pig iron	0.953	0.980
Metal additive per ton of pig iron	0.128	0.128

Blast furnace No 1 operated normally on the new coke and its productivity was maintained at the previous level.

In the second stage, all blast furnaces were converted to the new coke, eliminating the chance of any of the old charge being mixed with the new. During the first stage, it had been impossible to keep some sediment and dust of the old charge from being mixed with the new one. For 5 days during the second stage, coking was carried on with pure Variant III of Table 2 and the coke obtained had a low drum specimen and was not compact enough. To verify the hypothesis that the absence of sediments of the old charge from the new charge caused the poor quality of the coke, a somewhat fatter charge was coked during the last 5 days, consisting of 10 percent D coal, 23 percent K coal, 18 percent G coal, and 49 percent PZh coal. The coke obtained from this charge was characterized by a larger drum specimen.

The results of 10 days coking and blast-furnace melts in furnaces No 1 and No 4 during the second stage are given in the following table in which figures for the 1950 third-quarter plan also appear for purposes of comparison:

Table 7.

	<u>3d Qu Plan</u>	<u>Avg, 5 - 14 Aug</u>
Constituents of charge (%)		
D	--	10
G	19.0	19
PZh	44.5	47
K	10.5	24
PS	15	--
Total	100	100
Quality of ordinary charge (%)		
Sulfur content	2.53	2.53
Volatile matter	25.8	27.56
Quality of coke		
Ash content (%)	10.3	10.58
Sulfur content (%)	1.65	1.62
Drum specimen (kg)	320	318
Fracturing (cm/sq cm)	--	0.168

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Table 7. (Contd)

	<u>3d Qu Plan</u>	<u>Avg, 5 - 14 Aug</u>
Operation of blast furnaces		
Coefficient of utilization of volume (cu m/ton)		
Furnace No 1	0.95	0.93
Furnace No 4	0.82	0.78
Consumption of coke (ton)		
Furnace No 1	1.047	0.972
Furnace No 4	0.930	0.852

Experiments indicate that it is not expedient to divide long-flame coal at the Kurakhovka Mine No 40 into DM and DK types, since it is more efficient to clean run-of-the mine coal in a coal washer and not the grade less than 25 millimeters as in the experiments in the Yenakiyevo Plant. This represents a possible way of improving the quality of coke over that obtained in the second stage.

The Yenakiyevo Plant will have to operate for a long time (several months) on the new charge before all questions on the subject can be answered. After such a time, a study of the characteristics of the charge should be accelerated and it should be possible to choose the most favorable charge for coking. The most important phase of the procedure will be to pick for the charge these constituents which will assure the most favorable blast-furnace operation.

The use of long-flame coal at the Yenakiyevo Plant has saved 325,000 tons of the very scarce PS coal. On the basis of this saved coal, any plant can convert to a new charge without K coal. Furthermore, this is an experiment in operating on charges with new constituents. The experiment will later permit differentiating between charges for different plants according to the capacity of the blast furnaces, the assortment of pig iron to be smelted, the presence of sintering installations, coal-preparation plants, etc. As a result, it will be possible to concentrate more of the K and PS coal where the most powerful blast furnaces operate, where there are no sintering plants, etc. Finally, it will be possible to have some reserves of coking coal.

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